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The arcuate line of the rectus sheath – does it exist?*

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INTRODUCTION

The anatomy of the anterior abdominal wall has been redescribed. Each abdominal aponeurosis is bilaminar and each wall of the rectus sheath is trilaminar. The posterior lamina of the internal oblique emerges, in certain areas, deep to the transversus abdominis aponeurosis. All the aponeurotic layers cross to the opposite side forming several digastric muscles between the two sides (Rizk, 1976, 1980; Williams, Warwick, Dyson & Bannister, 1989).

This article describes the various anatomical features seen in the lower half of the posterior rectus sheath (PRS). These features differ markedly from the conventional picture that describes sudden shifting of the aponeuroses from the posterior to the anterior rectus sheath with the existence of a sharp, concave downwards, arcuate line (Williams & Warwick, 1980; Last, 1985; Moore, 1985; Moffat, 1987; Romanes, 1987).

MATERIALS AND METHODS

The anterior abdominal walls of 40 human cadavers were studied. The specimens included 26 males and 14 females, aged from newly born to 60 years of age. Each specimen was excised as one mass from the xiphoid process, above, to the symphysis pubis below and as far as the loins laterally. The specimens were taken within six hours after death, stretched on wooden frames (40 × 60 cm) by strong silk threads and fixed in 5% formalin solution in that position for 24 hours. This mild fixation for a short duration was intended to avoid shrinkage and distortion of the fibres. The specimens were carefully dissected, following the fibre bundles in each stratum, and photographed.

OBSERVATIONS

The anatomical features of the lower half of the PRS were determined by the rate of shifting of the fibres from behind the rectus to its front, the quantity of the shifted fibres and the architecture of the fibres remaining in the PRS.

Regarding the rate of shifting of the fibres to the front, in 28 specimens (70%) the shifting was very slow and gradual; the PRS was gradually thinned out but could be recognised down to the symphysis pubis (Fig. 1). In six specimens (15%), the rate of shifting of the fibres was rather rapid and/or irregular, so that the PRS became thickened again after being thinned out. This gave the picture of an ill-defined or double arcuate line (Fig. 2). In four specimens (10%), the shifted fibres were minimal so that the remaining PRS was almost of normal thickness and complete down to the symphysis pubis. Moreover, in two specimens (5%), a thick transverse aponeurotic

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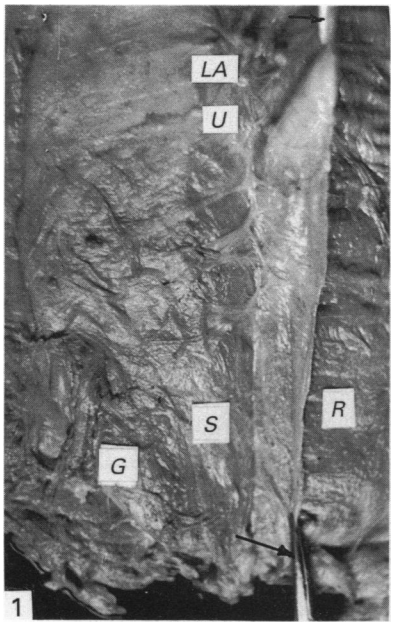
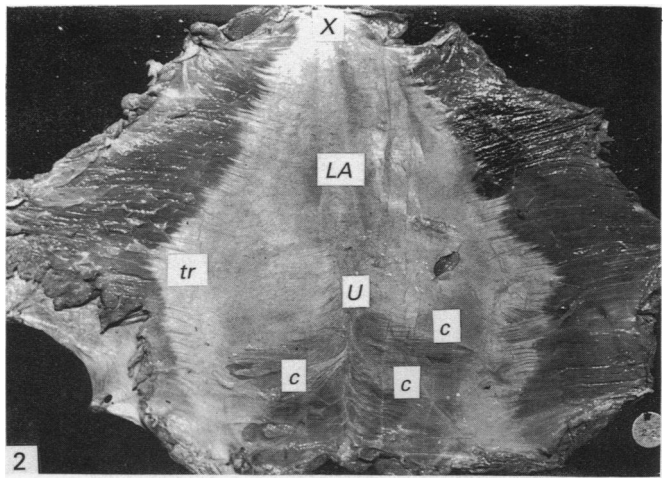
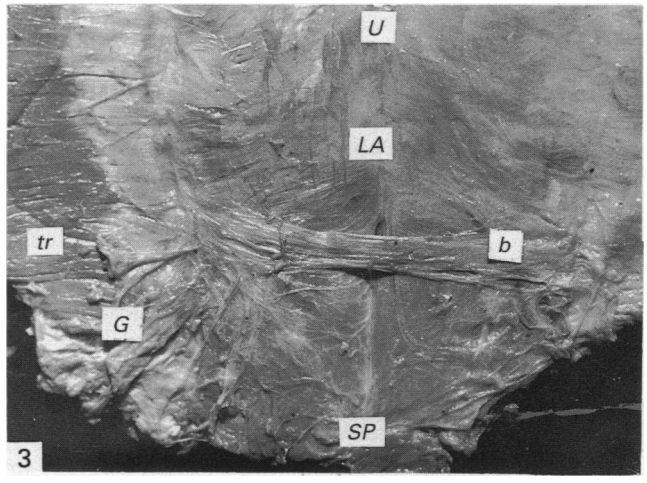






Abbreviations for all Figures: *b*, band of transverse aponeurotic fibres; *c*, arcuate line or its expected site if absent; *f*, dense aponeurotic fibres; *G*, inferior epigastric artery; *H*, hernial orifices; *LA*, linea alba; *R*, rectus abdominis muscle; *S*, posterior wall of the rectus sheath; *SP*, symphysis pubis; *tr*, transversus abdominis; *U*, umbilicus; *X*, xiphoid process.

Fig. 1. A posterior view of the infra-umbilical region. The right PRS is cut longitudinally in its middle line. Its lateral half is removed exposing the right rectus muscle, and its medial half is raised between the tips of two artery forceps (arrows) from the umbilicus to the symphysis pubis. It shows the gradual thinning of the PRS and the absence of the arcuate line.

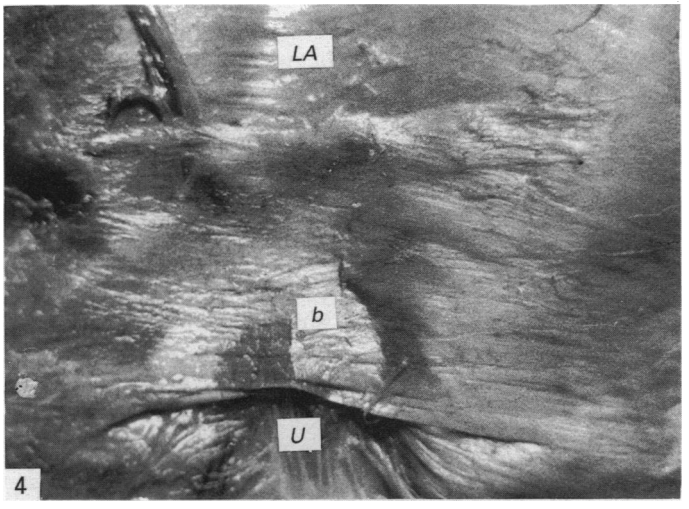
Fig. 2. A posterior view of a whole specimen, showing the shifting of the fibres to be rapid and irregular giving the appearance of an ill-defined (left side) and a doubled (right side) arcuate line.

Fig. 3. A posterior view of the infra-umbilical region showing a thick transverse aponeurotic band replacing the arcuate line and crossing from one side to the other.

Fig. 4. A posterior view of the umbilical region of the abdominal wall showing a dense transverse aponeurotic band crossing from one side to the other at the level of the umbilicus.

Fig. 5. A posterior view of a whole specimen showing a sharp concave arcuate line on the left side only; however, the right side of the same specimen shows a dense complete PRS down to the symphysis pubis. Multiple para-umbilical and a right direct inguinal hernial orifices could be seen.

Fig. 6. A posterior view of the infra-umbilical region showing a complete PRS down to the symphysis pubis; no arcuate line can be seen at its expected site (*c*). A dense transverse band of fibres (*f*) is curving from one side to the other just above the symphysis pubis.



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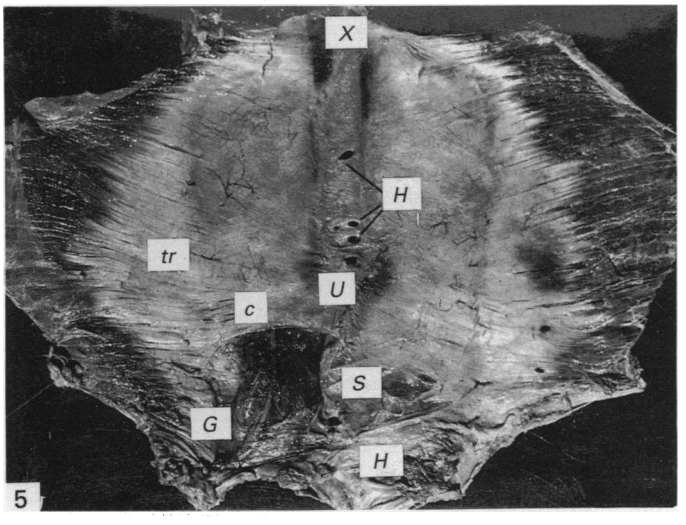

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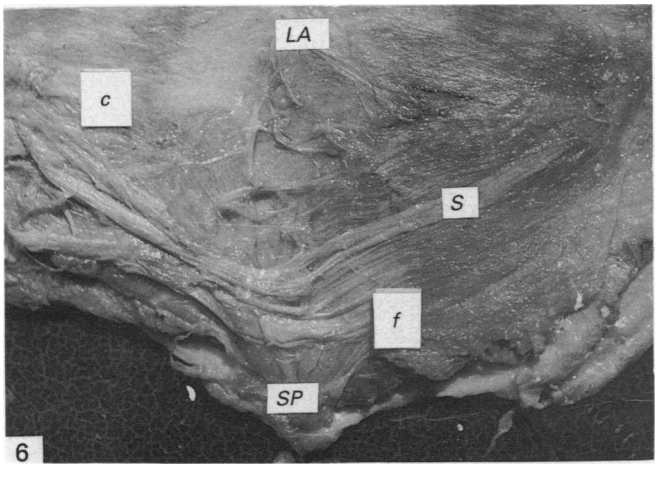

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band was seen replacing the arcuate line and extending from one side to the other (Fig. 3). A similar band was also seen in some specimens at the level of the umbilicus (Fig. 4). The classically described sharp concave arcuate line was seen on one side of one specimen only (Fig. 5). However, on the other side of the same specimen, the PRS was thick and complete down to the symphysis pubis. This specimen showed multiple hernial orifices and extensive fibrosis suggesting its possible pathological nature (Fig. 5).

Regarding the quantity of the shifted fibres, in 34 specimens (85%), whether the rate of shifting of the fibres was slow, rapid or irregular, the quantity of the shifted fibres was moderate. Thus, a thinned but always recognisable PRS was seen down to the symphysis pubis (Fig. 1). In the remaining six specimens (15%) the amount of the shifted fibres was minimal leaving a nearly complete PRS down to the symphysis pubis or even rethickened just above the symphysis pubis by a transverse band crossing from one side to the other (Fig. 6).

In a study of the architecture of the fibres remaining in the PRS, in 34 specimens (85%), the lower part of the PRS showed a delicate network of fibres with variable thickness. In six specimens (15%), a dense transverse aponeurotic band was seen crossing from one side to the other either at the level of the umbilicus, midway between the umbilicus and the symphysis pubis or just above the symphysis pubis (Figs. 4, 3, 6 respectively).

DISCUSSION

The present study throws further light on the various anatomical features seen in the lower half of the PRS. Starting from the level of the umbilicus, or even higher by 2·5 cm, the fibres of both layers of the PRS gradually shift to the anterior sheath. Thus, the anterior lamina of each of the internal oblique and transversus abdominis aponeuroses starts to increase gradually in thickness from the level of the umbilicus downwards at the expense of the thickness of the posterior laminae.

In the great majority of the present cases (70%), the rate of shifting of the fibres was very slow and gradual. This resulted in the complete absence of the arcuate line which, on the contrary, was replaced in some specimens by a thick well-formed transverse aponeurotic bundle (Fig. 3). Schaefer & Dancer early in 1894 stated that the arcuate line was sometimes indistinct and the posterior rectus sheath ended indefinitely in scattered bundles. Gardner, Gray & O'Rahilly (1963) also mentioned that the transversus abdominis was divided into two layers to enclose the rectus. In the author's opinion and also in the opinion of some other anatomists (Moffat, 1989), the arcuate line seen in the dissecting room is usually artificially created during dissection by removing the lower part of the PRS, considering it to be merely transversalis fascia.

In 15% of the present cases, the rate of shifting of the fibres from the posterior to the anterior rectus sheath was rapid or irregular. This gives the picture of an ill-defined or doubled arcuate line (Fig. 2). A sharp well-defined arcuate line can appear only if the fibres suddenly shift at a definite level. Woodburne (1961) stated "the transversus abdominis gives fibres that pass in front of the rectus at a variable level between the umbilicus and the arcuate line". McVay & Anson (1940) and Woodburne (1988) attributed the presence of multiple arcuate lines to the fact that the posterior lamina of the internal oblique ends at a different level from that of the transversus abdominis. Yuan Lung-Chin (1965) also observed that the arcuate line may be doubled.

In the remaining 15% of the present cases there was minimal shifting of the fibres

and a complete PRS, even thickened by dense transverse aponeurotic bands at variable levels (Figs. 3, 4, 6).

The functional significance of the fibre shifting from the posterior to the anterior rectus sheath is apparently passive support of the lower part of the abdominal wall which is fixed between the two iliac crests (Moffat, 1989). Due to the bulging of the abdomen, the lower part of the anterior abdominal wall becomes dependent and subjected to the weight of the internal viscera. The degree of the internal pressure gradually increases from above downwards with the increase in the curvature of the anterior abdominal wall. Through this curvature, the anterior abdominal wall changes from a vertical plane at the level of the umbilicus to an oblique one at the level of the symphysis pubis. As this change is normally very gradual, it seems logical that the corresponding shifting of the fibres should be similarly gradual.

The surgeon attempting to enter the lower abdominal or pelvic cavity should be familiar with the various anatomical features that he might be confronted with during his incision. As thickened transverse aponeurotic bands, at various levels, are not uncommonly met with, the horizontal curved suprapubic incision may be superior to a vertical incision since the former incision is parallel, and thus splitting, to most of the aponeurotic bundles of the region. It is also parallel to the skin creases and cleavage lines. On the contrary, the latter incision is destructive, not only to the transverse bands of the present study but also, to all the intermediate aponeuroses of the several abdominal digastric muscles mentioned before (Rizk, 1980).

SUMMARY

The lower halves of the anterior abdominal wall of 40 human specimens of both sexes and various ages were studied. The anatomical features seen were widely variable and quite different from the conventional picture. The fibres of the posterior lamina of the internal oblique and transversus abdominis aponeuroses gradually shift from the posterior to the anterior rectus sheath starting from the level of the umbilicus down to the level of the symphysis pubis. Thus, these anterior laminae gradually increase in thickness at the expense of their posterior laminae. As a result, the arcuate line is absent. Instead, one or more of the following features could be seen: (i) A gradually thinned out but complete PRS. (ii) An ill-defined or double arcuate line. (iii) A complete PRS of nearly normal thickness. (iv) A dense well-formed transverse aponeurotic band crossing from one side to the other at the level of the umbilicus, symphysis pubis or midway between them.

REFERENCES

GARDNER, E., GRAY, D. J. & O'RAHILLY, R. (1963). In *Anatomy: A Regional Study of Human Structure*, 2nd ed. Philadelphia, London: W. B. Saunders Co.

LAST, R. J. (1985). In *Anatomy Regional and Applied*, 7th ed., pp. 256–260. Edinburgh, London, Melbourne and New York: Churchill Livingstone.

MCVAY, C. B. & ANSON, B. J. (1940). Aponeurotic and fascial continuities in the abdomen, pelvis and thigh. *Anatomical Record* **76**, 213–231.

MOFFAT, D. B. (1987). In *Lecture Notes on Anatomy*, pp. 201–209. Oxford: Blackwell Scientific Publications.

MOFFAT, D. B. (1989). Personal communications.

MOORE, K. I. (1985). In *Clinically Oriented Anatomy*, 2nd ed., pp. 158–169. Baltimore, Hong Kong, London, Sydney: Williams & Wilkins.

RIZK, N. N. (1976). A new description of the anterior abdominal wall. *Anatomical Record* **184**, 515.

RIZK, N. N. (1980). A new description of the anterior abdominal wall in man and mammals. *Journal of Anatomy* **131**, 373–385.

ROMANES, G. J. (1987). In *Cunningham's Text-book of Anatomy*, 12th ed., pp. 354–363. Oxford, New York, Toronto: Oxford University Press.

SCHAEFER, E. A. & DANCER, G. (1894). In *Quain's Elements of Anatomy*, 10th ed., vol. II. London: Longmans, Green & Co.

WILLIAMS, P. L. & WARWICK, R. (1980). In *Gray's Anatomy*, 36th ed., pp. 551–559. Edinburgh, London, Melbourne and New York: Churchill Livingstone.

WILLIAMS, P. L., WARWICK, R., DYSON, M. & BANNISTER, L. (1989). In *Gray's Anatomy*, 37th ed., pp. 595–604. Edinburgh: Churchill Livingstone.

WOODBURNE, R. T. (1961). In *Essentials of Human Anatomy*, 2nd ed. New York: Oxford University Press.

WOODBURNE, R. T. & BURKEL, W. E. (1988). In *Essentials of Human Anatomy*, 8th ed., pp. 411–417. New York, Oxford: Oxford University Press.

YUAN LUNG-CHIN (1965). Constitution of the rectus sheath. *Acta anatomica sinica* **8 (2)**, 234–238.